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ABSTRACT

Volume 9 of the 19-volume Highway Safety Program Manual (which provides guidance to State and local governments on preferred highway safety practices) focuses on identification and surveillance of accident locations. The purpose of the program, its specific objectives, and its relationship with other programs are explored. Federal authority in the area of accident reduction and general policies regarding identification and surveillance programs are outlined. Program development and operations (aspects of coordination, data needs, and corrective action programs) are presented. Criteria for program evaluation and different types of reports (operational, program evaluation, and Federal Highway Administration) are explained. Local government participation is outlined. Appendixes contain the Highway Safety Program Standard Nine, Identification and Surveillance of Accident Locations; a glossary of definitions; references; a list of representative projects; and a list of resource organizations. (NH)

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Highway Safety NO. **9**

Program Manual

Identification and Surveillance of Accident Locations

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U.S. DEPARTMENT
OF TRANSPORTATION

FEDERAL HIGHWAY
ADMINISTRATION

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HIGHWAY SAFETY PROGRAM MANUAL

VOLUME 9

IDENTIFICATION AND SURVEILLANCE OF ACCIDENT LOCATIONS

This manual is designed as a guide for States and their political subdivisions to use in developing highway safety program policies and procedures. It does not supersede the requirements of Highway Safety Program Standard No. 9.

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FOREWORD

As part of the Highway Safety Program Manual, this volume is designed to provide guidance to State and local governments on preferred highway safety practices. Volumes comprising the Manual are

0. Planning and Administration
1. Periodic Motor Vehicle Inspection
2. Motor Vehicle Registration
3. Motorcycle Safety
4. Driver Education
5. Driver Licensing
6. Codes and Laws
7. Traffic Courts
8. Alcohol in Relation to Highway Safety
9. Identification and Surveillance of Accident Locations
10. Traffic Records
11. Emergency Medical Services
12. Highway Design, Construction, and Maintenance
13. Traffic Engineering Services
14. Pedestrian Safety
15. Police Traffic Services
16. Debris Hazard Control and Cleanup
17. Pupil Transportation Safety
18. Accident Reporting and Investigation

The volumes of the Manual supplement the Highway Safety Program Standards and present additional information to assist State and local agencies in implementing their highway safety programs.

The content of the volumes is based on the best knowledge currently available. As research and operating experience provide new insights and information, the Manual will be updated.

The volumes of the Highway Safety Program deal with preferred highway safety practice and in no way commit the Department of Transportation to funding any particular program or project.

Many expert organizations and individuals at all levels of government and in the private sector contributed heavily in the preparation of the volumes of the Manual. The Department appreciates greatly this help in furthering the national program for improving highway safety for all Americans.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

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I. INTRODUCTION

Death, injury, and property damage resulting from motor vehicle accidents on the highway can be considered the result of a variety of circumstances. A viable program should provide an effective means of identifying and quantifying the circumstances leading up to a crash, the injury-producing factors in the crash, and the activities following the crash that can lessen the continuing effects. A comprehensive three-phase approach along those lines will then point the way toward the development and implementation of more effective countermeasures that will produce significant reductions in the senseless losses in motor vehicle accidents.

II. PURPOSE

The purpose of the Program is to promote systematic analysis of the losses experienced in motor vehicle accidents; and thereby assist highway engineers and law enforcement and other safety program officials in focusing available resources upon corrective measures with highest priorities and best likelihood of producing significant improvements.

III: SPECIFIC OBJECTIVES

The specific objectives of the Loss Experience Analysis Program are to provide:

A. A sound basis for identifying those locations on streets and highways where accident loss experience is unusually high and where corrective measures are relatively straightforward as might be related to highway features, condition of facilities, or traffic operations.

B. An objective basis for assigning priorities to appropriate measures to reduce accidents or their severity in the

1. Improvement of highway design features

2. Improvement of traffic operation controls

3. Improvement of highway maintenance

4. Selective enforcement.

C. An objective basis for evaluating the effectiveness of accident reduction measures and programs.

D. A systematic, routinely implemented program for continuing surveillance of the highway systems, and for obtaining the information necessary for establishing priorities among alternative countermeasures that could lead to reduction of accidents and the attendant deaths, injuries, and property damage.

IV. RELATIONSHIP WITH OTHER PROGRAMS

The Surveillance or Loss Prevention Analysis Program as described here in Volume 9 is closely related to all other functional Program areas, but in particular with the Traffic Records and Police Traffic Services Programs described respectively in Volumes 10 and 15 of this Manual.

A. In general, the Surveillance Program focuses on the identification of problem locations in a State's urban and rural street and highway network, conducting field inspections and other investigations of problem locations once identified, establishing priorities for corrective measures among the problem locations, following up on their implementation, and ultimately evaluating their effectiveness.

B. The Traffic Records Program, covering the design and operation of the data base for all highway safety functional

program areas in a State, provides some (but not all) of the data needs of the Surveillance Program. The Surveillance Program, in turn, provides some specialized data to the general data base.

C. The Police Traffic Services Volume describes recommended practices in a number of areas of police traffic activity. This includes accident investigation which, for the most part throughout the nation, is handled by police personnel at the scene of an accident. As will be pointed out here, data recorded by police at the scene of an accident, particularly in fixing the location, are of vital importance to the Surveillance Program. The Surveillance Program, however, calls for substantial in-depth follow-up investigation of accidents by engineering and other agency personnel who usually will not be present at the accident scene. These follow-up data are important for enforcement as well as other purposes, and must, of course, be closely correlated with the data that police obtain at the scene.

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The authority for the Standard and the Highway Safety Program is contained in Chapter 4 of Title 23, U.S.C. (hereinafter referred to as the Highway Safety Act of 1966). Section 402(a) of Title 23 reads, in part:

> "(a) Each State shall have a highway safety program approved by the Secretary, designed to reduce traffic accidents and deaths, injuries, and property damage resulting therefrom. Such programs shall be in accordance with uniform standards promulgated by the Secretary. Such uniform standards shall ... include... surveillance of traffic for detection and correction of high or potentially high accident locations ...".

Based on this authority, the Secretary of Transportation has issued Standard 9, Identification and Surveillance of Accident Locations. The Standard appears as Appendix A.

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Par. I. Introduction
II. Policy

I. INTRODUCTION

The Identification and Surveillance of Accident Locations (Loss Prevention Analysis) Program should provide meaningful information to highway and law enforcement administrators and other groups responsible in other aspects of highway safety programs: for evaluating the conditions that create the problem situation; for planning, designing, and implementing appropriate corrective measures; and for evaluating the results produced by the countermeasures.

II. POLICY

A. Improvements should be sought in current and proposed methods: for fixing accurately the locations of accidents; for evaluating the conditions that create the problem at the sites; for processing the data and assuring the accuracy of the information; and for planning corrective measures by highway designers and traffic engineers, enforcement groups, and others responsible for highway safety programs.

B. Concepts and activities discussed in this volume should be used as guidelines in establishing performance criteria against which existing programs can be evaluated and toward which new programs should be developed.

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Par. I. Coordination
II. Data Needs
III. Corrective Action Programs
IV. Program Operation

I. COORDINATION

A. State and local highway engineering, traffic engineering, enforcement, emergency medical services, and other agencies have a common interest in thorough evaluations of problem locations where high accident frequencies and severities occur. Of central importance is the need for full coordination of all loss experience, such as procedures that are keyed to the location of accidents, to ensure that the requirements of all groups are met.

B. Joint corrective action by police, engineering, and other agencies is strongly recommended, although there will be situations that can be corrected solely by the action of one discipline.

C. Local agencies should conduct their own accident site location and loss analysis programs and maintain their own records. The State should provide guidance and assistance to local agencies, including summary data, as needed to carry out local programs. State and local agencies should coordinate efforts in development of methods of identifying the location of accidents, for conducting the investigations, and recording and later analyzing the information.

II. DATA NEEDS

To provide for adequate analysis of possible accident causes and contributing factors, and for planning appropriate corrective actions, an accident data system should contain accurate information on accident type, its location, the sequence of events* culminating in the crash, and other items.

A. Classification

Accident types and locations should be classified uniformly** to permit data from many accidents to be combined for purposes of analysis and objective comparisons.

B. Records

1. The data necessary for analyzing the comparative hazards of particular locations may be obtained from reports of specific accidents, records of traffic patterns, reports of field investigations, and records of highway environmental characteristics. Examples of relevant data that should be available for analyzing the comparative hazards among particular locations include, but are not limited to,

   a. Highway geometrics and surface conditions.

   b. Traffic volumes.

   c. Spot speeds.

   d. Traffic control devices.

   e. Contiguous land use.

   f. Maintenance records.

   g. Enforcement patrol schedules.

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*See Volume 10, Traffic Records, Appendix F, for an example of suggested uniform accident report forms.

**See Appendix C for references which contain classifications presently in use.

2. Data relative to the driver and the vehicle should be readily obtainable from individual accident reports. Characteristics and driving record of the involved driver (from the operator license number) and motor vehicle condition and inspection history (from the vehicle registration number) are to be derivable from the individual accident report. Wherever possible, control data involving driver and vehicle information on the overall population of drivers and vehicles passing a particular location, but not becoming involved in accidents, should also be obtained.

3. Various methods are used by States and local governments to establish and maintain records of the location of specific features and sections of roadways. Such methods are used for planning and keeping records of maintenance, capital improvements, and other operational requirements related to the physical plant. Several States are using special procedures such as videotape and time-lapse photography. Whatever it might be, the same system generally should be used to identify and keep records of accident locations for such purposes as

   a. Detecting at particular sites highway or traffic control deficiencies that create or increase hazard.

   b. Detecting at particular sites maintenance deficiencies that create or increase hazard.

   c. Establishing the locations that require increased levels of enforcement or other types of increased localized attention.

   d. Examining public reports of high hazard conditions.

4. It is desirable for State and local government units to identify and analyze hazardous locations on their own systems of roads and streets. Accident location patterns should be maintained to show sites where accident experience is higher than average and which should be given special study. Detailed analyses of the high accident locations may provide indications of highway or street features, enforcement practices, or other program elements needing correction. These relationships can be developed objectively by correlating accident, highway, and traffic characteristics.

5. In cases where there are low traffic volumes, the accident experience at a single location may not be adequate to identify and plan corrective action. However, by combining accident information from several locations which have similar features, an adequate basis for planning corrective measures may be obtained.

6. Evaluations of accidents and possible causal factors should be based on an adequate data base. Data from all systems should be readily available for Statewide analyses. This may be accomplished through uniform accident reporting to a central traffic records system* and/or compatibility between State and local accident and traffic records. State and local units could be considered to have compatible records when data are uniformly defined and classified and when data may be transferred from one system to another either directly or by using conversion formulae. Records need not be maintained in exactly the same format although this would be most desirable.

C. Accuracy

1. Levels of accuracy for locating the site of an accident should be adequate to identify sufficiently for later purposes of corrective action the roadway design and other environmental features that may have contributed to the hazard at the location. Both the points of initiation and termination of the accident sequence should be located by the investigating official, utilizing as a frame of reference any significant physical features of the crash site and its immediate vicinity. Recommended as minimum levels of accuracy are

   a. Measurement should be made to the nearest 1/100 of a mile for residential and commercial streets in urban areas, urban expressways and freeways, rural roads within the area of influence of an intersection, and all other locations where there is a convenient reference.

   b. In all other cases it is desirable to obtain as much accuracy as practicable under the conditions. Generally,

*See Volume 10, Traffic Records.

it is practical to measure accident locations to the nearest 1/100 of a mile using hundredth mile odometers. Odometers should be calibrated regularly in order to maintain accuracy.

III. CORRECTIVE ACTION PROGRAMS

A. There can be reasonable confidence in corrective action programs that are based on a thorough analysis of accident loss experience when such analyses are directly keyed to the locations at which the crashes are occurring. For example, in a selective enforcement program, an ongoing analysis of high accident locations will materially aid in an objective selection of enforcement measures among several alternatives.

1. Stationing a patrolman at specific locations during certain hours.

2. Generally increasing patrol coverage of stretches of highways or streets where there are high accident frequencies.

3. Conducting more selective speed enforcement coupled with recommendations to change speed zoning.

B. Corrective action programs in other functional areas in addition to selective enforcement will also be assisted by loss experience analysis keyed to the locations of crashes. These include highway spot improvement programs, traffic control improvement programs, maintenance, and other hazard reduction programs. There, accordingly, is a need for close cooperation among the agencies concerned with detailed loss experience analyses at accident locations. To cite several examples:

1. Signs, signals, and markings generally are the responsibility of the highway or traffic engineering organization.* Changes in the use of these devices at a particular accident location should be based on thorough analysis of the

*See Volume 13, Traffic Engineering Services.

accident experience there. Such changes, however, often are not exclusively problems for engineering analysis. Practical enforcement problems should be considered.

2. Spot improvement measures, including maintenance, should be considered in combination with other measures such as selective enforcement.

3. Recommendations to change speed zoning requires close coordination between enforcement and engineering agencies.

C. The use of multidiscipline teams is strongly recommended for accident site analysis. The teams, which would include representatives from enforcement, engineering, and other appropriate disciplines, would provide for full consideration of all possible corrective measures while avoiding duplication of effort. The team might be responsible for

1. Developing methods to identify high accident locations.

2. Analyzing specific high accident locations.

3. Recommending measures for reducing accidents at specific high accident locations.

4. Investigating potentially high accident locations.

5. Evaluating effectiveness of accident countermeasures that are introduced at specific locations or groups of locations.

D. The teams could be expanded (particularly at the State level) to include representatives from agencies such as health, education, driver licensing, motor vehicle registration, and others that are concerned with accident loss experience analyses, although with less interest than engineering and enforcement in linking the losses to specific locations.

E. The multidiscipline teams may be organized formally or informally, but it is important that procedures be established to assure that close cooperation and coordination are maintained between the teams, the operating elements of the agencies which they represent, and, wherever appropriate, trained researchers and laboratory workers.

IV. PROGRAM OPERATION

A. Accident reports

1. Accident reports submitted by police officers or other trained accident investigators are the foundation for the entire accident location and surveillance program.

2. Reports of individual vehicle operators may supplement those prepared by police or other trained investigators.

   a. In many States, the operators' reports are the only source of location data available for accidents not investigated by an officer, and while these reports may be deficient in some respects, they may provide certain useful information.

   b. The "station" or "off-scene" report is a type of operator's report which ordinarily is made at a police station or to an officer at a location other than the accident site. This type of report is preferable to a report that an operator prepares himself without discussions with the police.

3. Evaluations of indications of unreported accidents or near-miss accidents such as tire marks on pavement and curbs, damaged delineators and guard rail, and other telltale marks may reveal potentially hazardous locations. The program should include procedures that call for maintenance, police, or other personnel to report such indications, together with later procedures for systematic review and follow-up on the reports.

B. Reportability thresholds

Accident analysis programs within the State should be based upon uniformly reported data. Each State should therefore establish a Statewide reportability threshold at or above which all accidents are investigated and reported uniformly by reporting officials. A practical threshold would be one where officers' reports are required under any of the following conditions.

1. Death.

2. Injury.

3. Damage to a vehicle to the extent that the vehicle cannot be removed from the scene of the accident under its own power.

C. Supplemental (bi-level) reporting.

Special data requirements, in addition to those provided for in the standard reporting form, may be established for specific types of accidents or conditions to provide data for special analyses. For example, additional data may be desired on all accidents involving fire or leakage of liquids, or on particular types of accidents over a specified time period. In such cases requiring supplemental reporting, the investigating officer can provide the additional data on a supplemental report form.* Sampling plans should be considered and utilized wherever appropriate.

D. Referencing the accident locations.

Various procedures are suitable for referencing accident locations. In most common use are linear, coordinate, and links and nodes methods.**

1. Linear methods reference the locations on each street and highway by measuring the distance from the beginning of the road or some other origin to the desired location. Ordinarily the measurement is expressed in miles, stations, or feet. However, street and house numbers or other consecutive numbering systems can be used if other records, such as traffic volumes and geometrics, can be identified with accident locations specified in this manner. Linear referencing of accident locations depends upon the existence of reference points in the field. Field references include:

*See Volume 10, Traffic Records, Form A, Exhibit F, for a sample report form.

**See Appendix C for detailed materials on referencing methods.

a. Milepost markers.

b. Log mile markers.

c. Log mileage signs or stickers on structure and/or signs.

d. Street names and house numbers.

e. Intersections.

f. Easily recognizable landmarks.

2. Coordinate methods reference accident locations by grid coordinates.

   a. Coordinates can be assigned to an accident location at the site by using a grid map and landmarks for reference or in the office by using a grid map and the narrative description from the accident report. An urban area that is laid out in a consistent grid pattern could use house and street numbers as grid coordinate references.

   b. When accidents are referenced by coordinates and other highway records are referenced by linear methods, there should be a means for converting one or the other to achieve compatibility.

   c. Coordinate referencing systems which require special maps are not suited to operator reporting. The location of operator-reported accidents by coordinate references must be determined through office analysis.

   d. Coordinate referencing systems are particularly suited to the production of maps using electronic data processing methods.

3. Links and nodes referencing is basically a combination of the coordinate and linear referencing systems. Accident locations are referenced by linear measurements from a given node. Field markers, intersections, or any easily identified landmarks may be designated nodes in the system and the sections of highway between nodes are the links. The nodes are fitted into a theoretical grid system which

is particularly applicable to electronic data processing. Other highway records can be referenced by the same system.

E. Inventories of accident loss experience.

Inventories of accident loss experience are listings, periodically updated, of accident losses keyed to the location of occurrence. The overall purpose of the inventories is to aid in identifying locations where losses are abnormal or changing.

1. Inventories of accident loss experience should be developed and periodically updated according to an established schedule for all urban and rural highway and street systems in the State.

2. The highway section, intersection, or other element of a street network that is to be treated as a "location" for inventory purposes should be clearly defined.

   a. The definition should be keyed to the operational practices of various agencies: for enforcement it might be the beat; for highway engineering, a tangent section or length of roadway between two milepost markers; and for traffic engineering, an intersection.

   b. The definitions need not be the same for all operating agencies. However, all definitions should be mutually compatible and permit the effective aggregation of accident data for all operational purposes at State and local levels.

3. For each category of accident location, criteria as to what constitutes "high" accident loss experience should be established to aid in identifying where additional attention and resources allocations are required. Criteria as to what constitutes "low" accident loss experience are also necessary to aid in identifying locations from which resources may be diverted to high accident locations.

   a. The primary criteria for loss experience should be developed around numbers of accidents and the frequency and severity of the resulting injuries and property damage.

b. The loss criteria should be measured as accurately as possible for each location included in the inventory.

c. Loss experience at each location should be weighed by appropriate measures of exposure such as vehicle miles of travel, numbers of vehicles, or combinations, wherever such data can be obtained for each location as defined.

d. Statistical methods should be used to delineate changes in loss experience from trends, and otherwise to aid in interpreting the statistical and practical significance of loss data. Trend analyses and adaptations of industrial quality control statistical techniques to accident data analyses should be used wherever appropriate.

4. An important aspect of the inventory program is the method utilized to display the statistical data. The purpose of the display is to facilitate rapid and unambiguous interpretation of the accident loss experience to and in the identification of major problem locations. Techniques may vary from manual methods to more sophisticated electronic data processing or may involve combinations of manual and electronic methods. The formats may include

a. Conventional accident location maps.

b. Graphical charts.

c. Statistical control charts.

d. Statistical reports.

e. Direct (on-line) computer outputs.

F. Multisite data.

1. The principal inventories of accident loss experience should be maintained wherever possible on an individual location basis. Some applications, however, will require that accident loss and exposure data from several locations be grouped for meaningful interpretation. Generally, this is because meaningful statistical interpretations require either relatively high loss experience or exposure or both.

a. Local agencies with low volume roads and relatively few accidents will have to utilize techniques for grouping data from several locations.

b. Grouping should be limited to locations with similar features and traffic patterns to aid in identifying contributing factors which the grouped locations have in common.

c. Agencies should organize their records to provide for ready aggregation and interpretation of information from each of the locations combined in a group.

d. Appropriate statistical controls on exposure must be applied.

2. Another important reason for grouping data from several locations is to aid in pinpointing highway design and operating features associated with accidents.

a. Appropriately matched groups of locations should be identified for comparing loss experience associated with a particular design or operating feature.

b. Appropriate statistical controls on exposure must be applied.

c. Multifactor analysis techniques should be utilized wherever appropriate to isolate the effects upon accidents of a particular design or operating feature from those produced by all of the other factors present in the accident sequence.

d. Thorough preplanning of the statistical procedures for isolating the effects of a particular design or operating feature upon accidents should be required to a level of detail that demonstrates the soundness of the procedures and a reasonable chance of obtaining conclusive results.

G. Surveillance.

Surveillance programs fall into three general categories: (1) statistical surveillance, (2) preventative surveillance, and

(3) accident location surveillance. A fourth category of surveillance activities is the follow-up study.

1. Statistical surveillance.

As described in Section IVE of this chapter, the inventory of accident loss experience together with the statistical analysis of aggregated data and their display comprise an important aspect of an overall surveillance program.

2. Preventative surveillance.

The expression "preventative surveillance" is used here to describe a program of detailed field inspections or other examinations of the highway plant and its operation to detect hazardous conditions even before they contribute to significant accident losses. Although many engineering, enforcement, maintenance, or other operating personnel do perform routine inspections which include safety as well as other considerations, this program element calls for a safety-oriented examination of the operating network.

a. The preventative surveillance program should be operated on a schedule that assures that all major locational elements of the total network are examined for potential hazards at least once a year if there is no evidence of significant accident losses, and more frequently where such evidence exists.

b. Preventative surveillance should, wherever possible, be part of a clearly identified assignment in its own right, and not simply an additional task on other (than safety) surveillance requirements of engineering, enforcement, maintenance, or other operational personnel.

c. Multidiscipline teams, as described earlier in this chapter, should be utilized in preventative surveillance wherever possible.

d. Personnel performing the preventative surveillance should identify, report, and/or rectify possible hazardous conditions according to guidelines and procedures provided for these purposes.

e. Preventative and other field surveillance activities may be facilitated by using radar, television, and aerial and surface photography. Such systems presently are under study and test in several States and cities, primarily for immediate detection of accidents or other traffic disruptions. As more experience in the use of these devices is obtained, they can become an important part of the overall surveillance program.

3. Accident location surveillance.

Field inspections and other surveillance activities of accident locations by qualified operating personnel are required: (a) to determine the specifics of accident causation, (b) to establish the need, nature, and priorities of corrective measures, and (c) to evaluate the effectiveness of corrective measures.

a. All high accident locations should be subjected to detailed field inspections and related surveillance procedures.

b. A location where a fatality has occurred should be treated as a problem location requiring field surveillance, although not necessarily at the same priority as a high accident (frequency) location.

c. A sampling plan for conducting field surveillance of all other accident locations should be adopted and followed.

d. Multidiscipline teams should be used as much as possible at all problem locations, and to some extent at the other accident locations.

e. After high accident locations have been identified, field studies should be made to gather additional data related to possible engineering or enforcement measures to reduce hazardous characteristics of the locations. Determination of additional data needs, possible accident reducing measures, and other decisions related to analysis should be the responsibility of the primary agency involved with formal or informal assistance by the multidiscipline team where appropriate.

4. Follow-up surveillance.

Follow-up studies of improvements made a specific locations should be conducted to determine the effectiveness of the corrective measures. Similar field surveillance should be performed where new facilities have been constructed under regular programs to study changes having an apparent effect on accident experience. The effectiveness of the entire surveillance program depends substantially upon the scope and thoroughness of the follow-up or corrective measures suggested or recommended by the statistical, preventative, or accident location surveillance activities. This follow-up surveillance cannot be left to chance, but must be treated in a systematically planned manner.

a. There are no precise rules for planning follow-up surveillance, but in general, adequate time for the particular situation should be allowed to pass before follow-up surveillance is completed. This is to permit drivers to adjust to the new or changed driving conditions.

b. In some cases it may be necessary or desirable to make certain measurements, such as speed, volumes, and vehicle placement, to further analyze the effects produced by the change.

c. Results of follow-up surveillance may provide a basis for revision of existing design and construction standards or operating procedures.

d. Before-and-after studies are a basic evaluation technique which may be performed in different detail. Simplified treatments may be performed in the office using accident and traffic volume data. Other before-and-after studies may require detailed field data on traffic behavior in addition to accident and traffic volume data.

e. Before-and-after studies and other follow-up surveillance on corrective measures implemented at a specific location should consider accident experience at adjacent locations to determine whether changes in accident occurrence at these locations, if any, can be associated with the corrective action taken at the nearby site.

H. Systematic programs for corrective measures.

Recommendations on assignments of implementation priorities for accident reducing measures should be made using accident location and feature inventories, surveillance reports, effectiveness evaluation reports, and cost-effectiveness techniques.

1. Cost-effectiveness.

   a. Cost-effectiveness analyses enable a determination of the relative effectiveness of improvements. These analyses of accident reducing measures include techniques such as benefit-cost analysis, maximum net benefit analysis, or investment return analysis.*

   b. These analyses should consider traffic volumes, construction costs, and service life of improvements. They may also include engineering enforcement and maintenance costs, as well as related items such as projected traffic flow and interest rates.

   c. Cost data related to fatalities, injuries, and property damage, when used, should be consistent within the State.** Additional studies may be needed to develop a uniform method for costing accidents.

2. Typical programs.

   a. Programs in the following areas should be considered.

      (1) Spot improvements with priorities.

      (2) Design feature (criteria) changes.

      (3) Changes in traffic control policy or procedures.

      (4) Selective enforcement activities and schedules.

      (5) Maintenance policy and procedures.

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*See Appendix C of this volume for references on alternate methods of cost-effectiveness analysis.

**See Appendix C for references which contain examples of cost figures.

b. There also may be recommendations for actions under the programs of disciplines other than engineering and enforcement.

3. Specific improvements.

It is important in the design of safety improvements that safety considerations be applied to the total improvement and not only to the obvious deficiency to be corrected. For example, it may be possible to correct a hazardous crest vertical curve by lengthening the curve to increase sight distance. However, consideration should also be given to the clear roadside concept, slope treatment, and other safety features discussed in Volume 12, Highway Design, Construction, and Maintenance. It is also important to consider the impact on adjoining sections of highway when designing the improvement of a specific spot location. Failure to recognize this concept may result in the introduction of additional hazard in the facility.

I. Forecasts of accident reduction.

1. Forecasts of accident reduction potential of engineering and enforcement measures should be developed to aid in the selection of accident reducing measures at high accident locations. Before-and-after studies provide the basis for estimates of accident reductions related to specific improvements. To date, this basis for forecasting has been handicapped by small samples coupled with variations between locations. Before-and-after studies should be refined, where possible, by analyzing the relationships of accident types and physical features. Large samples of data generally are required to provide the necessary degree of refinement and statistical reliability.

2. Inventories reflecting accident occurrences related to road design characteristics and operating features also can provide data to develop forecasts where changes in accident rates can be related to changes in geometrics, traffic controls, or enforcement characteristics.

3. Forecasts should consider expected variation in traffic volumes due to construction in the vicinity or other changes in traffic flow patterns.

J. Training needs.

Adequately trained personnel are required to implement an effective program of identification and surveillance of accident locations. Generally the requirements relate to specialized training for selected personnel in operating agencies to aid both in the conduct of agency functions and in serving on multidiscipline teams.

1. Accident investigators.

The skill of the police officer (or other person) conducting the accident investigation at the scene is a critical factor in effective identification and surveillance of accident locations. He should, therefore, be thoroughly familiar with the techniques of accident investigation in general, but specifically in the needs of surveillance programs. He should be trained

a. To report locations accurately in accordance with the established locating system(s).

b. To report unusual aspects of the highway, traffic, operational controls, environment, the vehicle, and the driver that could have contributed to the accident.

c. In basic fundamentals of traffic engineering such as speed zoning and analysis of intersection conflicts.

d. In basic aspects of the mechanical behavior of the motor vehicle.

e. In basic aspects of medical problems of drivers.

2. Traffic engineering personnel.

Traffic engineering personnel should be trained in applications of conventional traffic engineering practices to the surveillance program requirements. They should be trained

a. To recognize relationships between accidents or potential accidents and characteristics of the highway, traffic controls, lighting, enforcement, etc.

b. In analytical procedures followed in developing engineering solutions.

c. To recognize possible solutions involving appropriate action by other disciplines, such as enforcement.

d. In the fundamentals of statistical analysis and cost-effectiveness analysis.

3. Highway maintenance personnel.

Highway maintenance field personnel should be trained to recognize in the course of their regular duties any deficiencies of the highway or other hazardous conditions. They should further be instructed to report the conditions and correct them where they are able to do so. On-the-job training courses for maintenance personnel accordingly should include

a. Recognition of problem locations.

b. Guidelines as to when to attempt corrective repairs themselves.

c. Techniques for corrective repairs.

d. Deficiency reporting.

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Par. I. Evaluation Summary
II. Evaluation Guidelines
III. Measures
IV. Evaluation Questions

I. EVALUATION SUMMARY

The Standard provides that the program shall be periodically evaluated by the State and that the Federal Highway Administration shall be provided with an evaluation summary.

II. EVALUATION GUIDELINES

Program evaluation should be performed by all agencies involved in identification and surveillance of accident locations.

A. At the State and local operating level evaluations may be appropriate to determine the following:

1. Whether existing procedures are capable of providing desirable levels of performance.

2. What changes and improvements need to be made to attain desirable levels of performance.

3. Manpower, fiscal, and time needs to attain these levels of performance.

4. Effectiveness of individual accident reducing measures.

5. Overall effectiveness of operating units.

B. At the local agency administrative level evaluations may be appropriate to determine the following:

1. Individual agency progress toward attaining desired goals.

2. Budget needs of individual units.

3. Relative effectiveness of individual programs.

4. Total effectiveness of the local units' combined program.

5. Need and extent of interagency cooperation.

C. At the State administrative level evaluations may be appropriate to determine the following:

1. Progress of individual State agencies and local units or agencies toward the State's program goals.

2. Budget needs of State and local agencies.

3. What programs are most desirable from a cost-effective viewpoint.

4. Program priorities.

5. Availability of funds including Federal-aid programs.

6. Effectiveness of individual State agency and local unit programs.

7. Effectiveness of the total State and local highway safety effort.

8. Need and extent of interagency and interunit cooperation.

D. Evaluation of individual accident reducing measures should be made as soon as adequate data are available.

III. MEASURES

Programs should be evaluated using performance measures and effectiveness measures.

A. Performance measures.

Performance measures indicate program accomplishments related to recommended levels of performance. Examples of specific performance measures are

1. Extent of statewide uniform accident reporting procedures.

2. Percent of total highway and street mileage on which recommended locating precision has been obtained.

3. Percent of accidents investigated by officers thoroughly trained in accident reporting.

4. Percent of State agencies and local units using recommended analytical methods and the multidiscipline team concept.

5. Percent of State agencies and local units performing effectiveness evaluations of individual accident reducing measures.

6. Extent to which statewide traffic records compatibility has been achieved.

7. Number of recommended accident reducing measures.

8. Number and cost of implemented accident reduction measures.

B. Effectiveness measures.

Effectiveness measures indicate the extent of the reduction of hazards at street and highway locations. Examples of effectiveness measures are

1. Increase or decrease in number of accidents at improved locations.

2. Increase or decrease in accident rates at improved locations.

3. Increase or decrease in accident severity at improved locations.

4. Increase or decrease in the number of scrape marks on structures, tire marks, guard rails, dents, etc.

5. Changes in driver behavior.

6. Reduction in average cost of accident damage and loss.

7. Benefit-cost ratio of improvement.

8. Net benefit of improvement.

9. Return on investment of improvement expenditure.

IV. EVALUATION QUESTIONS

The following set of questions may be used as a sample checklist to assist in evaluating the program for identification and surveillance of accident locations.

A. For what percent of existing freeways, expressways, and rural road mileage is there a method of locating accident sites from records to a precision of 1/100 of a mile?

B. What type of system is used on freeways, expressways, and rural road mileage to locate accident locations (i.e., linear methods, links and nodes, coordinates)?

C. Are field reference markers used? If yes, what spacing is used?

D. For what percent of existing residential and commercial street mileage in urban areas is there a method of locating sites from records to a precision of 1/100 of a mile?

E. Is there a procedure for inventorying high accident locations on highway systems? If yes, what percent of roadway mileage is included in the inventory program?

F. Does the inventory procedure include a method for relating related and operating features with high accident experience?

G. For what percent of existing road mileage is there a procedure to take appropriate measures to correct high or potentially high accident locations and evaluate the effectiveness of these improvements?

H. On what percent of the existing road systems is there a continuing surveillance of high and potentially high accident locations?

I. On what percent of the existing system are high accident locations investigated by multidiscipline teams who are responsible for recommending corrective action to the appropriate agencies?

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Par. I. Introduction
II. Operational Reports
III. Program Evaluation Reports
IV. Reports to the Federal Highway Administration

I. INTRODUCTION

Highway safety programs to reduce accidents or their severity should be evaluated to monitor progress against the program plan and to evaluate the effectiveness of accident reducing measures.

II. OPERATIONAL REPORTS

The following are examples of reports needed for the operation of identification and surveillance programs as recommended in Chapter IV.

A. Accident reports.

B. High accident location inventories.

C. Inventories of design and operating features.

D. General field surveillance reports.

E. Specific location surveillance reports.

F. Reports on the priority assignment of correctable locations.

G. Before-and-after evaluation reports of individual improvements.

III. PROGRAM EVALUATION REPORTS

Reports should be developed to justify program recommendations and document program results.

A. Intra-agency reports.

Reports are needed by highway and law enforcement agency management to justify and document project or program recommendations, to establish new programs, and to evaluate project or program accomplishments. Cost-effectiveness analyses, as recommended in Chapter IV, should be contained in these reports. Examples include

1. Report of safety program recommendations.
2. Report on approved programs.
3. Progress reports on projects under way.
4. Reviews of program accomplishment.
5. Financial status report.

B. Interagency reports.

Interagency reports may include the following:

1. Project submitted by local agency to State.
2. Report on local needs determination.
3. Report on priority program.
4. Report on accomplishments.
5. Report on overall program requirements.
6. Reports to provide program guidance.

C. Public information reports.

These may be as follows:

1. Overall program report on needs, individual programs, finances, accomplishments.

2. Reports to develop public understanding of specific highway safety activities.

IV. REPORTS TO THE FEDERAL HIGHWAY ADMINISTRATION

The FHWA intends to request periodic summary information from the States to assist in an appraisal of the program. These reports should describe measures taken or programs developed including methods, cost, staffing, effectiveness, and recommendations for further action or modifications in future programs. The State should receive evaluation reports from all local units and should issue a summary report annually to local units and the FHWA to summarize progress and effectiveness of the program. It is anticipated that these summary reports will contain information similar to that specified in paragraph IV of Chapter V, and paragraphs II and III of this chapter.

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Par. I. Responsibilities
II. Responsible Agencies
III. Actions

I. RESPONSIBILITIES

A. In most States the responsibility for investigating accidents, maintaining traffic records, and identifying, analyzing, and correcting high accident locations on local road and street system falls to local governmental units. Local units should exercise these responsibilities in cooperation with the State. The State should provide guidelines to assist the local units.

B. State guidelines should be flexible to provide for different sizes and capabilities of local units. Small local units can use methods such as accident location maps for carrying out the responsibilities appropriate to their size. These methods should be compatible with their locating and records systems.

C. The system of each local unit for identification and surveillance of accident locations should meet the Statewide guidelines provided by the State subsystem of the statewide traffic records system. Local units should be responsible for maintaining certain minimum levels of data in a form compatible with statewide procedures and should obtain advice and guidance from the State before changing their local procedures. *

*See Volume 10, Traffic Records.

D. Local units should be responsible for evaluating their own programs and submitting evaluation reports and other information necessary to manage the total State highway safety program.

E. Although the local units should identify and remedy their own accident locations, they should also furnish the State with data necessary for analyses that may not be performed in jurisdictions with low volume roads. In return for this cooperation, the State can furnish summary data to the local units.

II. RESPONSIBLE AGENCIES

Local agencies with primary responsibility for the identification and surveillance of accident locations are the traffic police agencies and engineering agencies. Agencies and their activities are

A. Traffic police.

1. Traffic law enforcement.

2. Selective enforcement.

3. Establishing the locations of accidents.

B. Engineering (highway and traffic).

1. Analyzing specific high accident locations for safety deficiencies in design, traffic patterns, maintenance, or other operational feature of the physical plant.

2. Recommending measures for correcting safety deficiencies at specific locations.

3. Assigning priorities to capital improvements and maintenance schedules and other operating procedures.

4. Compiling an inventory of design and operating features associated with accidents.

C. Either police or engineering.

1. Identifying high accident locations.

2. Compiling inventories of locations where accidents are increasing.

III. ACTIONS

A. Local governmental units in cooperation with State agencies should agree upon and use a uniform accident report form.* Minimum reporting thresholds and levels of accuracy in establishing the location of accidents should be maintained by local units in accordance with State guidelines. This may be accomplished either through cooperative arrangement or by requirement under State law.

B. Local jurisdictions should establish a uniform method for locating accidents on all roads and streets which will provide data compatible with the State's system.

C. Program actions of large local units should parallel those of State agencies. Smaller local units may not have the capabilities for automated data processing and may lack the personnel to perform detailed engineering analyses of accident locations. However, record needs are commensurately less and even in the smallest local unit manual records can be developed and managed for adequate identification and surveillance.

*See Volume 10, Traffic Records, Form A, Appendix F, for a sample standard police traffic collision report.

APPENDIX A

HIGHWAY SAFETY PROGRAM STANDARD 9

IDENTIFICATION AND SURVEILLANCE OF ACCIDENT LOCATIONS

PURPOSE

To identify specific locations or sections of streets and highways which have high or potentially high accident experience, as a basis for establishing priorities for improvement, selective enforcement, or other operational practices that will eliminate or reduce the hazards at the location so identified.

STANDARD

Each State, in cooperation with county and other local governments, shall have a program for identifying accident locations and for maintaining surveillance of those locations having high accident rates or losses.

I. The program shall provide, as a minimum, that

A. There is a procedure for accurate identification of accident locations on all roads and streets.

1. To identify accident experience and losses on any specific sections of the road and street system.

2. To produce an inventory of

a. High accident locations.

b. Locations where accidents are increasing sharply.

c. Design and operating features with which high accident frequencies or severities are associated.

3. To take appropriate measures for reducing accidents.

4. To evaluate the effectiveness of safety improvements on any specific section of the road and street system.

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B. There is a systematically organized program

1. To maintain continuing surveillance of the roadway network for potentially high accident locations.

2. To develop methods for their correction.

II. The program shall be periodically evaluated by the State and the Federal Highway Administration shall be provided with an evaluation summary.

APPENDIX B

GLOSSARY OF DEFINITIONS

This glossary defines those terms whose meanings may be unclear in the context in which they are used. These definitions are meant to apply only to the usage of these terms in this volume.

Accident - Any unplanned event that results in injury, property damage, or loss.

Accident Report - A written report containing data concerning an individual accident including time, place, location description, property damage, injuries, violations, and possible cause. Such reports are submitted either by the investigating officer or the involved motorists.

Accuracy - The degree of freedom from error by which a measurement is taken or an operation performed. For example, if a measurement is stated as 1.02 + 0.05, accuracy is plus or minus five hundredths.

Benefit-Cost Ratio - The economic value of assumed reduction in fatalities, injuries, and property damage divided by the cost of the accident reducing measure.

Coordinate Referencing Systems - Methods for accurately locating individual accidents by grid coordinates.

Effectiveness Measures - Indications of the extent to which program objectives are being attained.

Engineering - Pertaining to highway and traffic engineering, includes design, construction, maintenance, and traffic engineering and other branches having to do with the physical highway plant.

Inventories - Lists of items or occurrences such as roadway and roadside features, accidents, high accident locations, etc.

Investment Return - A measure of cost-effectiveness, the time required to obtain a return on an investment.

Linear Reference Systems - Methods for accurately locating individual accidents by longitudinal distance down the highway from a known starting point.

Link and Node Reference Systems - Methods for accurately locating individual accidents by longitudinal distance down the highway from a referenced node.

Multidiscipline Team - A group of two or more analytical personnel with at least one representative from the engineering and enforcement agencies and, if desired, representatives from other agencies assigned to advise and assist in the analyses of crash occurrences and in recommendations and evaluations of corrective measures.

Net Benefit - A measure of cost-effectiveness, gross benefit minus improvement cost.

Performance Measures - Indications of the extent to which programs are being performed in accordance with standards.

Reporting Threshold - The extent of personal injury or vehicle damage at or above which all accidents are reported.

Supplemental (Bi-Level) Reporting - A prescribed minimum amount of information would be collected on every reportable accident and a supplemental report would include additional data concerning items of special interest. The supplemental data are usually collected on a sample basis.

APPENDIX C

REFERENCES

The following is a selected list of authoritative references which contain detailed information on concepts and techniques discussed in this volume.

American Association of State Highway Officials. Road User Benefit Analysis for Highway Improvements (1960). American Association of State Highway and Transportation Officials, 341 National Press Building, Washington, D. C. 20004.

This manual describes benefit-cost analysis methodology highway improvements.

American Association of State Highway Officials. Highway Design and Operational Practices Related to Highway Safety, A Report to the Special AASHO Traffic Safety Committee (1967). American Association of State Highway and Transportation Officials, 341 National Press Building, Washington, D. C. 20004.

Cribbins, Paul D. "Investment Return Analysis: A New Approach for Scheduling Improvements at Hazardous Highway Locations," Traffic Engineering, Volume 38, No. 7, April 1968, pp. 32-40. Institute of Traffic Engineers, Inc., 1815 N. Fort Myer Drive, P.O. Box 9234, Arlington, Va. 22209.

This article compares investment return analysis with other methods for determining the cost-effectiveness of safety improvements, such as benefit-cost ratios and net benefit analyses.

Jorgensen, Roy, and Associates, and Westat Research Analysts, Inc. Evaluation of Criteria for Safety Improvements on the Highway (1966). Federal Highway Administration, U.S. Department of Transportation, Washington, D. C. 20590.

This report to the Bureau of Public Roads contains methods for identifying high accident locations, forecasting accident reduction through highway improvements, and evaluating proposed improvements for cost-effectiveness.

Insurance Institute for Highway Safety. A Summarized Review of Mileposting on State Maintained Highways in the United States (1967). Insurance Institute for Highway Safety, Watergate Six Hundred, Washington, D. C. 20037.

This publication describes milepositng systems in various States. Cost figures and design features are given in several instances. This is not a critical review and does not provide guidelines for selecting a system.

National Safety Council. Manual on Classification of Motor Vehicle Traffic Accidents, Second Edition (1970). National Safety Council, 425 N. Michigan Avenue, Chicago, Illinois 60611.

Definitions of motor vehicle accidents are contained in this manual. Included in these definitions are location nomenclature, types of accident configurations, standard symbols for accident collision diagrams, and levels of severity.

Recht, J. L. How to Do a Cost/Benefit Analysis of Motor Vehicle Accident Countermeasures (1966). National Safety Council, 425 N. Michigan Avenue, Chicago, Illinois 60611.

This report, as its title implies, gives concise directions for performing cost/benefit analyses of safety improvements. Several hypothetical examples are presented.

Smith, Richard N. Surveillance of Accident Locations by Electronic-Processing Methods (1967), Record 188. Highway Research Board, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

This report describes the methodology used by a large western State to identify accident clusters for investigation. The computer outputs used for this surveillance-identification process and subsequent printouts of detailed accident data for accident analyses are illustrated and their function described. The identification process consists of a computer search for accident clusters.

U. S. Department of Transportation. Highway Location Reference Methods (February 1972). U. S. Department of Transportation, Federal Highway Administration, Washington, D. C. 20590.

U. S. Department of Transportation. Manual on Uniform Traffic Control Devices for Streets and Highways (1971). Superintendent of Documents, Government Printing Office, Washington, D. C. 20590.

APPENDIX D

REPRESENTATIVE PROJECTS

The following is a list of typical projects which are eligible for Highway Safety grant funds and which contribute to improving highway safety.

1. Photologging highways for accident location reference.

2. Cooperative efforts by a number of counties to develop a uniform field reference system for roads under their jurisdiction.

3. Development of a computerized traffic accident location system for the purpose of fast, accurate, and economical access to accident files and statistics.

4. Improve present computerized accident surveillance system to reduce time spent on manual tabulations.

5. Development of computer techniques to produce collision diagrams.

6. Adding traffic volume information and highway inventory data to computerized accident data files to improve the capability to identify hazardous locations and routes.

7. State furnishing reports to local jurisdictions of high accident locations and hazardous areas in their jurisdictions.

8. Develop standard procedures for the identification and surveillance of high accident locations by a small city that can be used as a guide by other small cities.

9. Inventory need, plan and install field reference system for accident location.

10. On-site investigation, analysis and ranking of high accident locations.

11. Multidisciplinary teams to investigate accident sites in order to determine the design and operating features with which highway accident frequencies or severities are associated.

12. Investigate and evaluate intersections with high nighttime accident rates.

13. Develop programs for improvements at high accident locations and revision of design and operating features that contribute to accidents.

14. Follow-up analyses to determine the effectiveness of highway safety improvements.

15. Hire traffic engineers to assist local jurisdictions in identifying and correcting high accident locations.

16. Train selected employees to recognize existing potential hazards and take corrective actions to eliminate the hazards before accidents take place.

17. Hire personnel to analyze accidents and develop improvement programs.

APPENDIX E

RESOURCE ORGANIZATIONS

The following are organizations which can provide additional information on techniques discussed in this volume.

American Association of State Highway and Transportation Officials (AASHTO)
341 National Press Building
Washington, D.C. 20004

Federal Highway Administration
U.S. Department of Transportation
Washington, D.C. 20590

National Highway Traffic Safety Administration
U.S. Department of Transportation
Washington, D.C. 20590

National Safety Council - Traffic Accident Data Project
425 North Michigan Avenue
Chicago, Illinois 60611

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